TECHNICAL PAPER

STANDARDIZED UXO DEMONSTRATION SITES

NAEVA GEOPHYSICS, INC. – EM61-MKII/MAN-PORTABLE

BLIND GRID SCORING RECORD NO. 666

The EM61 MKII in the man-portable platform is shown being demonstrated by Naeva.

The EM61 MKII in the man-portable platform was demonstrated by Naeva at the Yuma Proving Ground Standardized Demonstration Site's Blind Grid Area. This technical paper contains the results of that demonstration. This is a reference document only and does not serve as an endorsement of the demonstrator's product by the US Army or the Standardized UXO Technology Sites Program.

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Technologies under development for the detection and discrimination of unexploded ordnance (UXO) require testing so that their performance can be characterized. To that end, Standardized Test Sites have been developed at Aberdeen Proving Ground (APG), Maryland and Yuma Proving Ground (YPG), Arizona. These test sites provide a diversity of geology, climate, terrain, and weather as well as diversity in ordnance and clutter. Testing at these sites is independently administered and analyzed by the government for the purposes of characterizing technologies, tracking performance with system development, comparing performance of different systems, and comparing performance in different environments.

The Standardized UXO Technology Demonstration Site Program is a multi-agency program spearheaded by the U.S. Army Environmental Center (USAEC). The U.S. Army Aberdeen Test Center (ATC) and the U.S. Army Corps of Engineers Engineering Research and Development Center (ERDC) provide programmatic support. The program is being funded and supported by the Environmental Security Technology Certification Program (ESTCP), the Strategic Environmental Research and Development Program (SERDP) and the Army Environmental Quality Technology Program (EQT).

DEMONSTRATOR'S SYSTEM AND DATA PROCESSING DESCRIPTION

Dual EM61 MKII/hand held: This system will be employed to survey the Calibration Lanes, the Blind Test Grid, the Open Field Site, and the Desert Extreme Site. During the fall of 2003, NAEVA developed and field tested a new towed-array system for the Geonics EM61 MKII. Two 1- by 0.5-meter coils were encased in a durable polyplastic sled that rested directly on the ground. Coil heights can be adjusted using inflatable air bladders within the sled, but are typically maintained at the standard height of 40 cm above the ground, equivalent to mounting the coils on their standard wheels. The system is towed by an eight-wheeled Argo all-terrain vehicle. A 16-foot tongue attaches the coil assembly to the Argo and maintains sufficient separation so that the vehicle does not influence the geophysical data. A single Global Positioning System (GPS) sensor is mounted over the center of the two coils to provide real-time positional tracking capabilities. System electronics are securely mounted in the vehicle's rear compartment, and the data loggers are located in the driver's compartment to allow continuous monitoring of system function.

The system was designed with the goal of quickly collecting the highest quality geophysical data on a modular, reusable platform. The smooth-bottomed sled allows the system to negotiate rough terrain without the jarring and associated mechanical noise usually found in wheel-mounted systems. Light-weight and durable, the polyplastic shell is composed of several pieces that

can be quickly replaced if field repairs are necessary. In addition, the coils are fully enclosed during operation, allowing the towed-array a degree of weatherproofing not usually found in geophysical equipment.

The EM61 is a time-domain electromagnetic instrument designed to detect, with high spatial resolution, shallow ferrous and nonferrous metallic objects. The applicability of the instrument for ordnance and explosives (OE) detection has been widely demonstrated at sites across the United States. Each instrument consists of two air-cored coils (1 by 0.5 m), batteries, processing electronics, and a digital data recorder. The larger of the two coils functions as the electromagnetic (EM) source and receiver and is positioned 40 cm below a second receiver coil. Secondary currents induced in both coils are measured in millivolts (mV).

Geonics has recently updated their standard EM61 system to the EM61 MKII. The primary difference in the MKII system is the use of multiple time gates. A time gate is the time after the electromagnetic pulse is generated that the receiver coil measures the response. The standard EM61 offers a single time gate in both the bottom and the top coils. While the top coil time gate is unchanged, the MKII records early, middle, and late channels from the bottom coil. The late time gate (third channel) corresponds to the standard EM61, and the earlier time gates offer enhanced capabilities for the detection of smaller metallic objects. Data from all three channels will be stored and processed during the demonstrations at APG.

Single EM61 MKII: This system will be employed to survey the Calibration Lanes, the Blind Test Site, and the Mogul Challenge. In an effort to maintain the highest standards for quality data acquisition in an area suspected to have small munitions, the EM61 will be operated in a litter/strecher configuration, where the coils are supported by 12-foot-long fiberglass poles and transported by two operators. The data logger and backpack will be controlled by the operator at the back of the system. Coil height, consistent with the towed-array at 40 cm, will be maintained through the use of harnesses worn by both operators. NAEVA has found data quality in the tandem configuration to be superior to wheeled operation in all but the smoothest terrain.

Performance Summary

Results for the Blind Grid test broken out by size, depth and nonstandard ordnance are presented in the table below. Results by size and depth include both standard and non-standard ordnance. The results by size show how well the demonstrator did at detecting/discriminating ordnance of a certain caliber range. The results are relative to the number of ordnance items emplaced. Depth is measured from the geometric center of anomalies.

The Response Stage results are derived from the list of anomalies above the demonstrator-provided noise level. The results for the Discrimination Stage are derived from the demonstrator's recommended threshold for optimizing UXO field cleanup by minimizing false digs and maximizing ordnance recovery. The lower 90 percent confidence limit on probability of detection and Pfp was calculated assuming that the number of detections and false positives are binomially distributed random variables. All results have been rounded to protect the ground truth. However, lower confidence limits were calculated using actual results.

Summary of Blind Grid Results for EM61 MKII/Man-Portable

Metric	Overall	Standard	Nonstandard	By Size			By Depth, m		
				Small	Medium	Large	< 0.3	0.3 to <1	>= 1
RESPONSE STAGE									
P_d	1.00	1.00	1.00	0.95	1.00	1.00	1.00	0.95	1.00
P_d Low 90% Conf	0.95	0.92	0.92	0.90	0.90	0.85	0.95	0.85	0.72
P_d Upper 90% Conf	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P_{fp}	0.95	-	-	-	-	-	0.95	0.95	NA
P_{fp} Low 90% Conf	0.93	-	-	-	-	-	0.92	0.87	-
P_{fp} Upper 90% Conf	0.98	-	-	-	-	-	0.99	1.00	-
P_{na}	0.00	-	-	-	-	-	-	-	-
DISCRIMINATION STAGE									
P_d	0.55	0.50	0.65	0.80	0.45	0.20	0.65	0.50	0.30
P_d Low 90% Conf	0.49	0.41	0.52	0.67	0.29	0.08	0.54	0.35	0.08
P_d Upper 90% Conf	0.65	0.62	0.77	0.87	0.59	0.42	0.75	0.65	0.60
P_{fp}	0.55	-	-	-	-	-	0.50	0.75	NA
P_{fp} Low 90% Conf	0.48	-	-	-	-	-	0.40	0.62	-
P_{fp} Upper 90% Conf	0.61	-	-	-	-	-	0.55	0.86	-
P_{na}	0.00	-	-	-	-	-	-	-	-

Response Stage Noise Level: 1.00
Recommended Discrimination Stage Threshold: 80.50

Note: *The recommended discrimination stage threshold values are provided by the demonstrator.*

To view the full Scoring Record for this demonstration and for all other demonstrations conducted at the Aberdeen and Yuma Proving Grounds in support of the Standardized UXO Technology Demonstration Sites Program please visit our Web site at: www.uxotestsites.org.